AIRS/AMSU/HSB Version 7 Retrieval Flow

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1 INTRODUCTION TO V7 RETRIEVAL FLOW

The mainline AIRS Version 7 (V7) system is an “AIRS-mostly” system which is not exactly like any of the V6 systems, but is designed to make the best use of the available data to generate the most consistent data record possible. The available well-behaved MW channels (3, 8-13) are utilized in the V7 neural network for the mainline “AIRS-Only” V7 system, but no MW channels are used in the physical retrieval.

A separate “AIRS/AMSU” data stream utilizing twelve AMSU channels (all except 4, 5, and 7) is being produced from September 2002 through September 2016 when AMSU-A2 failed. This V7 AIRS/AMSU system is analogous to the mainline V6 AIRS/AMSU system which was produced from 2002 to 2016.

All quantities marked **best** (associated quality factor = 0) and almost all quantities marked **good** (associated quality factor = 1) have passed through the entire retrieval system. It may be helpful to some users to understand the processing paths by which termination of the V7 retrieval process can occur. The steps are single-path sequential for V7, but early termination occurs when something fails along the way. There are four possibilities, listed below.

- Retrievals falling into cases 3 and 4 are considered to be successful retrievals. Products should be used or avoided as indicated by their individual quality flags. The user is encouraged to read **V7_L2_Quality_Control_and_Error_Estimation.pdf,** which describes the individual quality flags.
- Retrievals falling into case 1 should not be used for any purpose.
- Retrievals falling into case 2 reliably contain only microwave products.

1. Data are incomplete due to instrument, sensor or downlink problems. All values will be fill values (-9999), with quality factor 2. During the first ten years of operation, beginning September 2002, this happened in slightly less than 1% of Version 5 retrievals and we do not expect the frequency of occurrence to be different in Version 7.
2. The retrieval initiates, but some step does not succeed due to calculation problems (non-invertible matrices corresponding to unobservable variables, etc.) All data are marked quality 2, but depending on the point in the retrieval process wherein the failure occurred, some data fields may be populated and others may have fill values. We estimate this occurs in 0.2% of retrievals.
3. All steps succeed through final temperature retrieval, but failure occurs in retrieval of CO or CH_4. CO or CH_4 are marked bad (associated quality flags set to 2), and other products are marked as in case 4. The

frequency of occurrence of this case is uncommon.

4. All steps execute. Quality control is applied as described in the document, **V7_L2_Quality_Control_and_Error_Estimation.pdf**. We estimate 99% of retrievals are in this case.

A step-by-step comparison of V6 and V7 retrieval flow follows.

2 COMPARISON OF V6 AND V7 RETRIEVAL FLOWS

Version 6 AIRS/AMSU	Version 7 AIRS/AMSU (Available through September 2016)	Version 7 AIRS-Only (THIS IS THE MAINLINE SYSTEM FOR V7)
MW-Only Retrieval X_{CLIM}, $R_{MW} \rightarrow X_{MW}$ (ε_{MW}, q_{liq}, C_s)	**MW-Only Retrieval** X_{CLIM}, $R_{MW} \rightarrow X_{MW}$ (ε_{MW}, q_{liq}, C_s)	
Neural Network R_{MW}, $R_{IR} \rightarrow X_{NN}$	**Neural Network** R_{MW}, $R_{IR} \rightarrow X_{NN}$	**Neural Network** $^*R_{MW}$, $R_{IR} \rightarrow X_{NN}$
AMSU Retrieval R_{MW}, $X_{NN} \rightarrow X_0$ (update **T**, ε_{MW})	**AMSU Retrieval** R_{MW}, $X_{NN} \rightarrow X_0$ (update **T**, ε_{MW})	set $X_0 = X_{NN}$
Cloud Parm Ret 1 α_0, P_c^0	**Cloud Parm Ret 1** α_0, P_c^0	**Cloud Parm Ret 1** α_0, P_c^0
1st Cloud Clearing R_{IR}, $X_0 \rightarrow \hat{R}_{IR}^0$	**1st Cloud Clearing** R_{IR}, $X_0 \rightarrow \hat{R}_{IR}^0$	**1st Cloud Clearing** R_{IR}, $X_0 \rightarrow \hat{R}_{IR}^0$
AMSU Retrieval R_{MW}, $X_0 \rightarrow X_1$ (update **T**, ε_{MW})	**AMSU Retrieval** R_{MW}, $X_0 \rightarrow X_1$ (update **T**, ε_{MW})	set $X_1 = X_{NN}$
Cloud Parm Ret 2 α_1, P_c^1	**Cloud Parm Ret 2** α_1, P_c^1	**Cloud Parm Ret 2** α_1, P_c^1
(continued next page)	**(continued next page)**	**(continued next page)**

Version 6 AIRS/AMSU	Version 7 AIRS/AMSU (Available through September 2016)	Version 7 AIRS-Only (THIS IS THE MAINLINE SYSTEM FOR V7)
2nd Cloud Clearing R_{IR}, $X_1 \rightarrow \hat{R}^1_{IR}$	2nd Cloud Clearing R_{IR}, $X_1 \rightarrow \hat{R}^1_{IR}$	2nd Cloud Clearing R_{IR}, $X_1 \rightarrow \hat{R}^1_{IR}$
Physical Retrieval 1 X_1, $\hat{R}^1_{IR} \rightarrow X_{PHYS}$ (T_s, ε_{IR}, ρ_{IR}, T, q, O_3)	Physical Retrieval 1 X_1, $\hat{R}^1_{IR} \rightarrow X_{PHYS}$ (T_s, ε_{IR}, ρ_{IR}, T, q, O_3)	Physical Retrieval 1 X_1, $\hat{R}^1_{IR} \rightarrow X_{PHYS}$ (T_s, ε_{IR}, ρ_{IR}, T, q, O_3)
AMSU Retrieval R_{MW}, $X_{PHYS} \rightarrow X_{test}$ (for quality control)	AMSU Retrieval R_{MW}, $X_{PHYS} \rightarrow X_{test}$ (for quality control)	
Cloud Parm Ret 3 $\alpha 2$, P_c^2	Cloud Parm Ret 3 $\alpha 2$, P_c^2	Cloud Parm Ret 3 $\alpha 2$, P_c^2
3rd Cloud Clearing R_{IR}, $X_{PHYS} \rightarrow \hat{R}^2_{IR}$	3rd Cloud Clearing R_{IR}, $X_{PHYS} \rightarrow \hat{R}^2_{IR}$	3rd Cloud Clearing R_{IR}, $X_{PHYS} \rightarrow \hat{R}^2_{IR}$
Physical Retrieval 2 X_1, X_{PHYS}, $\hat{R}^2_{IR} \rightarrow X_{final}$ (T_s, ε_{IR}, ρ_{IR},T, CO, CH_4)	Physical Retrieval 2 X_1, X_{PHYS}, $\hat{R}^2_{IR} \rightarrow X_{final}$ (T_s, ε_{IR}, ρ_{IR}, T, q, O_3, CO, CH_4)	Physical Retrieval 2 X_1, X_{PHYS}, $\hat{R}^2_{IR} \rightarrow X_{final}$ (T_s, ε_{IR}, ρ_{IR}, T, q, O_3, CO, CH_4)
Choose Surface for Cloud/OLR Calculation $S_{OLR} = X_0$ or X_{final}	Choose Surface for Cloud/OLR Calculation $S_{OLR} = X_0$ or X_{final}	Choose Surface for Cloud/OLR Calculation $S_{OLR} = X_0$ or X_{final}
Cloud Parm Ret 4 $\alpha 3$	Cloud Parm Ret 4 $\alpha 3$	Cloud Parm Ret 4 $\alpha 3$
4th Cloud Clearing R_{IR}, $X_{PHYS} \rightarrow \hat{R}^3_{IR}$	4th Cloud Clearing R_{IR}, $X_{PHYS} \rightarrow \hat{R}^3_{IR}$	4th Cloud Clearing R_{IR}, $X_{PHYS} \rightarrow \hat{R}^3_{IR}$
X_{final}, $S_{OLR} \rightarrow$ OLR	X_{final}, $S_{OLR} \rightarrow$ OLR	X_{final}, $S_{OLR} \rightarrow$ OLR
Error Estimates δX	Error Estimates δX	Error Estimates δX
Quality Control	Quality Control	Quality Control

3 NOTATION

3.1 Atmospheric States

$\mathbf{X_{CLIM}}$ climatology atmospheric state, with the addition of the AVN surface pressure derived from the 3, 6, and 9-hour forecasts

$\mathbf{X_{MW}}$ atmospheric state derived by MW-Only Retrieval (product)

$\mathbf{X_{CR}}$ atmospheric state derived by Cloudy Regression

$\mathbf{X_{NN}}$ atmospheric state derived by Stochastic Cloud Clearing/Neural Network

$\mathbf{X_{REG}}$ atmospheric state derived by Regression

$\mathbf{X_{PHY}}$ atmospheric state derived by Physical Retrieval

$\mathbf{X_n}$ n_{th} atmospheric state

$\mathbf{X_{test}}$ derived atmospheric state used only for quality control

$\mathbf{X_{final}}$ final atmospheric state derived by physical retrieval algorithm

$\mathbf{S_{OLR}}$ surface parameters used for clouds and OLR

$\mathbf{X_{OUT}}$ atmospheric state reported as product

$\delta\mathbf{X}$ error estimate for atmospheric state product

Note: The climatology atmospheric state is derived from ECMWF.

3.2 Operations

$\mathbf{X_a ® X_b}$ retrieval of atmospheric state “b” starting from state “a”

$\mathbf{X_c}\rightarrow$ derivation of parameter(s) from atmospheric state “c”

3.3 Physical Parameters

$\mathbf{R_{MW}}$ observed MW radiances

$^{*}\mathbf{R_{MW}}$ observed MW radiances from AMSU channels 6, 8-13 only

$\mathbf{R_{IR}}$ observed (cloudy) IR radiances

$\hat{\mathbf{R}}_{IR}^{c}$ cloud cleared IR radiances derived from atmospheric state “c”

α_n cloud fraction, iteration “n”

P_c^n cloud top pressure, iteration “n”

$\mathbf{q_{liq}}$ liquid water content from MW-Only Retrieval

$\mathbf{C_s}$ surface classification from MW-Only Retrieval

ε_{MW} surface emissivity from MW-Only Retrieval

ε_{IR} surface emissivity in infrared

ρ_{IR} surface reflectivity in shortwave infrared

$\mathbf{T_s}$ surface skin temperature

OLR outgoing longwave radiation product

T T_{air} profile product

q precipitable water vapor profile/burden product

$\mathbf{O_3}$ ozone profile/burden product

CO carbon monoxide profile/burden product

$\mathbf{CH_4}$ methane profile/burden product

(a, b, c) retrieve physical parameters a, b, c

(update a, b, c) update previously retrieved parameters a, b, c

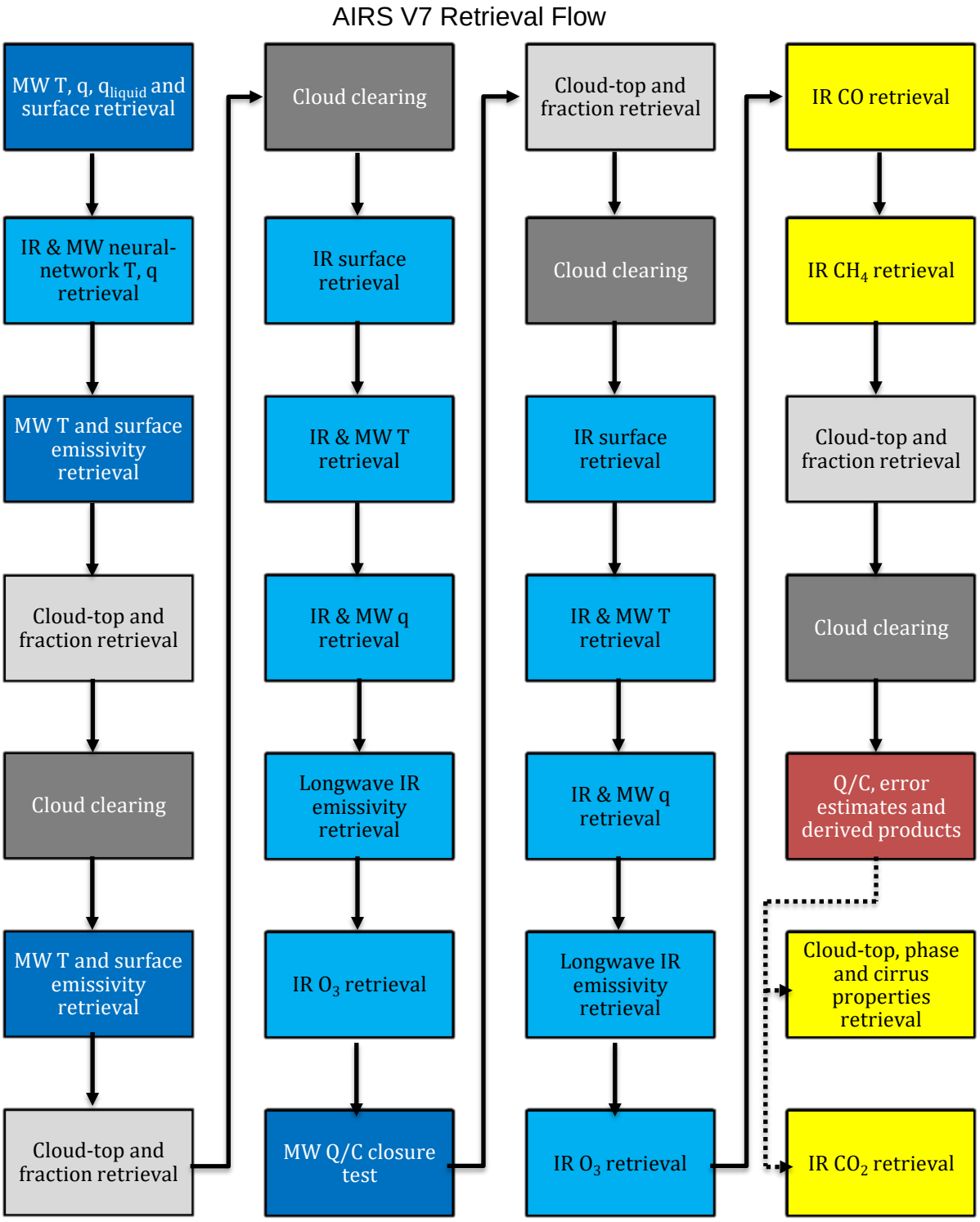

Figure 1: Graphical depiction of the AIRS V7 retrieval flow steps. Dark blue boxes (MW steps) apply only to the AIRS/AMSU and AIRS/AMSU/HSB systems and are omitted in the mainline V7 system. In the light blue boxes (IR/MW steps), except in the neural network step, the mainline V7 system omits any use of the MW channels. Light gray boxes refer to cloud pressure and fraction retrievals. Dark gray boxes indicate the cloud clearing steps. The red box indicates the main outputs from the retrievals. The yellow boxes occur in post-processing steps.